Fremont STEM
Tutoring | Hands-On Science | Consulting

Course Syllabus

AP Chemistry | Fall 2020 – Spring 2021

Objective: To gain an understanding of chemical concepts and their theoretical and practical applications.

Prerequisites: It is helpful, but not necessary, to have experience from a first-year high school chemistry course.

Instructor Contact Information:

Scott Clark scott.clark@fremontstem.com

Website:
All course materials (waiver, syllabi, etc.) will be posted on the course website (via Google Classroom) under "AP Chemistry". The website will be accessible throughout the school year for summer students.

Class Times:
Lecture: Sunday 4:00 PM – 6:30 PM
In-person lab: TBD

Required Materials:

- Notebook for taking notes
- Folder for handouts, worksheets, etc.
- Calculator
- Pencils, erasers, etc.
- Closed-toed shoes (for labs)
- Hair ties (for long hair on lab days)

Books and Course Material: All required materials for the course not listed above will be provided to the student on the first day of class. These include:

- A course reader that will serve as the textbook for the course. Purchase of the textbooks listed below is NOT necessary for successful participation in the summer STEM class. (~150 pgs)
- A laboratory manual listing all the lab experiments that will be done over the course of the summer, including safety guidelines, experimental procedures, and space to record data collected in lab. This will be graded for completion at the end of the course. The laboratory manual also contains an appendix of useful data tables and a standard-issue periodic table. (~45 pgs)
- A lecture notebook containing outlined lecture notes for the student to follow along during lecture. (~70 pgs)
- **The lecture notebook, course reader, and lab manual may contain elements that are the copyrighted intellectual property of the instructor and/or Fremont STEM, and may not be reproduced or distributed without prior written permission.

It is the student's responsibility to come to class prepared. Students should bring all three booklets to class every day because material covered in lecture is inextricably tied to the week's laboratory experiments and vice versa.

Homework: There will be homework problems assigned that are mandatory, as well as some more challenging problems that are optional**.** Answer keys will be available online the day the homework assignment is due. For help on practice problems, feel free to email me.

Quizzes: In order to keep everyone up to speed on the material being covered, online quizzes will be assigned after each lesson. These are short (15 minutes) and will cover the most recent lecture's material. Please feel free to use any course materials, including the reader, lecture notes, or lab manual, to complete the quiz. Quizzes are accessible on the course website.

Lab quizzes must be completed BEFORE participation in the laboratory session. These are short quizzes scored for points that seek to make sure the student is aware of the day's lab experiment as well as the associated procedure and any safety precautions. Students who fail to complete the pre-lab quiz will be asked to take the quiz before beginning the day's experiment. This is to make sure everyone is on the same page with regard to lab safety.

Textbooks:

Note: Purchase of an AP chemistry textbook is NOT required for participation in the course. All necessary materials will be provided in the coursework folders handed out on the first day of class.

Primary text:

Njoo, E.S. ***Chemical Fundamentals: AP Chemistry Reader***.Edumax, Inc., 2016. [provided in course]

Brown, Theodore E; LeMay, Eugene H; Bursten, Bruce E; Murphy, Catherine; Woodward, Patrick; and Stolzfus, Matthew E. ***Chemistry: The Central Science***,13th edition. AP edition. Pearson, 2014.

Supplementary text:

Chang, Raymond and Goldsby, Kenneth E. ***Chemistry***,11th edition. McGraw-Hill Education, 2011.

Lab safety: Safety is of first priority. All students and parents are expected to have read and understand the Lab Safety and Liability waiver. This form is sent out in the registration email and must be turned in before the first day of lab. Inappropriate lab behavior that puts the student or other students in potentially dangerous situations may result in the instructor asking the student to sit out during lab and the student forfeiting participation in that day's experiment.

Notes: Please bring a notebook and pencil to take notes. This is not graded or collected, but it is a good habit to always take notes in any class for future reference, studying, or staying awake during lecture.

Midterm and Final Exam: All students are encouraged to take the final exam, which will be assigned on the second to last day of class to be taken in a 90 minute timeframe. No cheating or extra time is permitted, on the honor system. The corrected tests with feedback will be returned during the following lecture, where we will discuss any questions as a class. The purpose of the final exam is to make sure the information taught is being retained and to quantitatively assess the students' progress in their understanding of chemistry-related concepts. A midterm will also be administered halfway through the course to gauge students' progress and to maintain accountability for learning the material well.

Tentative Nature of the Syllabus: The contents of this syllabus and attached schedule are tentative in nature and may be subject to change or revision. The instructor holds the right to make changes to the schedule and/or organization of the class as necessary. Students and parents will be identified of any changes via email.

Fremont STEM
Tutoring | Hands-On Science | Consulting

Special Accommodations: If your student requires special accommodations, please notify the instructor as soon as possible.

Tentative Schedule

Week	Date	Lecture/Lab	Topic
Week 1	9/13/20	Lecture 1	Introduction to Chemistry; Data Analysis, Atomic Structure
Week 2	9/20/20	Lecture 2	Electron Configurations and Quantum Mechanics
Week 3	9/27/20	Lab 1	Intro to Laboratory Equipment and Safety; Density Virtual Activity
Week 4	10/4/20	Lecture 3	Periodic Trends, Chemical Bonding, Nomenclature, and Molecular Geometry
Week 5	10/11/20	Lecture 4	Mole Conversions, Empirical Formula, and Calculations in Chemistry
Week 6	10/18/20	Lecture 5	States of Matter and Intermolecular Forces
Week 7	10/25/20	Lecture 6	Gas Laws
Week 8	11/1/20	Lab 2	Molecular Geometry Modeling, VSEPR Simulations (Molecular Mechanics)
Week 9	11/8/20	Lecture 7	Solutions and Colligative Properties
Week 10	11/15/20	Lecture 8	Solutions and Colligative Properties
Week 11	11/22/20	No Class	Thanksgiving Break
Week 12	11/29/20	Lab 3	Chemical Formula of a Hydrate Salt (Virtual)
Week 13	12/6/20	Lecture 9	Chemical reactions, Stoichiometry and Limiting Reagents **Midterm 1**
Week 14	12/13/20	Lecture 10	Review Midterm
Week 15	12/20/20	No Class	Winter Break
Week 16	12/27/20	No Class	Winter Break
Week 17	1/3/21	Lecture 12	Chemical Equilibrium
Week 18	1/10/21	Lecture 13	Chemical Equilibrium cont'd
Week 19	1/17/21	Lab 4	Freezing Point Depression of DMSO Virtual Lab
Week 20	1/24/21	Lecture 14	Acids and Bases
Week 21	1/31/21	Lecture 15	Acids and Bases cont'd
Week 22	2/7/21	Lecture 16	Thermochemistry and Thermodynamics
Week 23	2/14/21	Lecture 17	Thermochemistry and Thermodynamics cont'd
Week 24	2/21/21	Lecture 18	Electrochemistry
Week 25	2/28/21	Lecture 19	Electrochemistry cont’d

Week 26	3/7/21	Lab 5	Survey of Chemical Reactions (Virtual)
Week 27	3/14/21	Lecture 19	AP Test Prep
Week 28	3/21/21	Lecture 20	AP Test Prep
Week 29	3/28/21	Lecture 21	AP Test Prep
Week 30	4/4/21	No Class	Spring Break
Week 31	4/11/21	Lecture 22	AP Test Prep
Week 32	4/18/21	Lecture 23	AP Test Prep
Week 33	4/25/21	Lecture 24	AP Test Prep
Week 34	5/2/21	Lecture 25	AP Test Prep
Week 35	5/9/21	Lecture 26	Nuclear and Organic Chemistry
Week 36	5/16/21	Lecture 27	Nuclear and Organic Chemistry
Week 37	5/23/21	Lecture 28	TBD: Special Topics and/or Labs
Week 38	5/30/21	Lecture 29	TBD: Special Topics and/or Labs
Week 39	6/6/21	Lecture 30	TBD: Special Topics and/or Labs

Note: Lecture and lab days are subject to change if unexpected circumstances arise. Labs will be virtual until public health policy orders permit in person labs.

Learning Outcomes:

- Students will be able to describe the basic structure of an atom as it consists of protons, neutrons, and electrons; and how the relative numbers of these contribute to atomic mass, atomic number, mass number, and charge.
- Students will understand the concept of the mole and Avogadro's number and how this is used in quantifying matter.
- Students will be taught the basics of laboratory safety and the various types of chemical glassware.
- Students will gain a conceptual understanding of the nature of chemical bonding and will learn how to name ionic and covalent compounds.
- Students will apply their understanding of molecular geometry to predict molecular polarity and intermolecular forces present in the particular compound.
- Students will be able to conduct basic dimensional analysis calculations and apply these to stoichiometric calculations.
- Students will apply stoichiometric calculations to limiting reagent and percent yield problems.
- Students will predict reaction products based on the nature of the reactants and products.
- Students will conceptually understand electron configurations based on Hund's rule, the Aufbau principle, the Heisenberg Uncertainty Principle, and quantum numbers.
- Students will understand the basic principles behind the Schrodinger wavefunction of electrons ($H\Psi=E\Psi$).
- Students will understand the conceptual basis for molecular geometry and electron-domain geometry using valence shell electron pair repulsion (VSEPR) theory and predict the geometry of molecules.
- Students will understand the nature of chemical bonding via both the valence bond theory (VBT) and molecular orbital theory (MOT) and predict paramagnetism and diamagnetism of compounds.
- Students will be able to calculate concentration of solutes based on molarity, molality, etc. and will be able to describe mathematical bases of colligative properties.
- Students will be able to describe the effects of solute concentration on Absorbance of a solution via Beer-Lambert's Law and how this can be used to quantitatively analyze the progress of a reaction.
- Students will understand what is meant by an "ideal solution" and how Raoult's Law and Henry's Law are followed with respect to the ideality of the solution.
- Students will investigate Beer-Lambert's Law and how absorbance of light is correlated with solute concentration.
- Students will be able to correlate molarity and molality of a solution given the density.
- Students will be able to quantify the properties of gases as equations of state and predict gas ideality and behavior correspondence with the ideal gas equation and the relationship between pressure, temperature, volume, and moles.
- Students will be able to calculate the root mean square speed of gas molecules and understand the relationship between molecular weight and RMS velocity at a given temperature.
- Students will understand how Graham's Law of Effusion correlates molecular weight with rate of effusion.
- Students will use Maxwell-Boltzmann Distributions to describe the effects of molecular weight and temperature on the distribution of molecular speeds in a sample.
- Students will be able to balance and classify various types of chemical reactions.
- Students will understand the principles of nuclear decay and nuclear reactions such as fission and fusion and how this can be used in energy production and in WMD.
- Students will predict nuclear stability based on proton-to-neutron (p/m) ratios and the band of stability.
- Students will predict types of nuclear decay based on the nuclear topography of an isotope.
- Students will understand basic organic molecule nomenclature and be able to identify organic molecule functional groups.

- Students will be able to describe the nature of chemical equilibrium and apply Le Chatelier's principle to understand equilibrium shifts and how relative concentration and temperature of reaction affect the extent of equilibrium.
- Students will understand the basis of chemical solubility and how various factors in solution affect it.
- Students will understand various definitions of acids and bases and how titrations can be conducted to determine the concentration of an unknown. Students will be able to create titration curves based on laboratory data and describe how indicators and burets can be effectively used.
- Students will gain an appreciation for the Henderson-Hasselbalch Equation and how it is used in weak acid/base titrations or in buffer solutions.
- Students will gain a basic understanding of chemical kinetics and rate law applications of reaction rate and how reaction mechanisms are elucidated based on empirical data.
- Students will analyze chemical kinetics from both a differential rate law (instantaneous rate) and an integrated rate law ([A] vs. t) for zeroth order, first order, and second order reactants.
- Students will understand how activation energy is related to the rate constant ***k*** given the Arrhenius equation and will be able to use the Arrhenius equation to predict the effects of temperature on reaction rate.
- Students will understand various thermodynamic and thermochemical principles including experimental calorimetry, enthalpy, Gibbs Free Energy, and Entropy; and how the laws of thermodynamics can be applied to chemical systems.
- Students will be introduced to the Boltzmann Equation and how the entropy of a system can be calculated from the natural logarithm of the number of microstates.
- Students will be introduced to electrochemistry and how redox reactions can be coupled in electrochemical cells in their modern applications. Students will gain experience with oxidation numbers and reduction/oxidation reactions.
- Students will understand the relationship between equilibrium constant (K), Gibbs Free Energy (ΔG) and the electrochemical potential (E) and how these are related. Students will gain an appreciation for modern chemistry and its biological, physical, and engineering-based applications.